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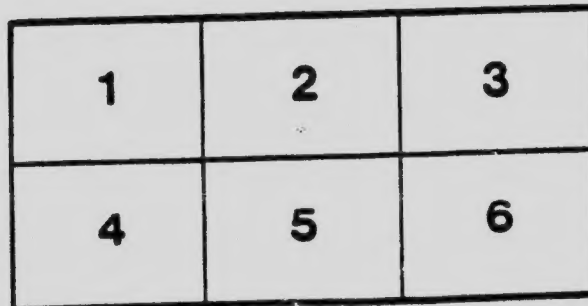
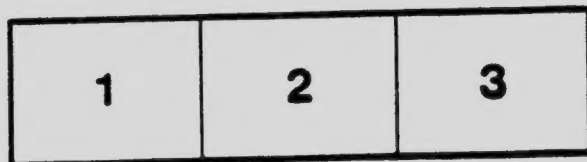
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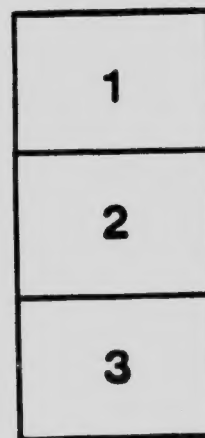
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Histories of New Food Fishes

II. The LUMPFISH

By

PHILIP COX, Ph.D.

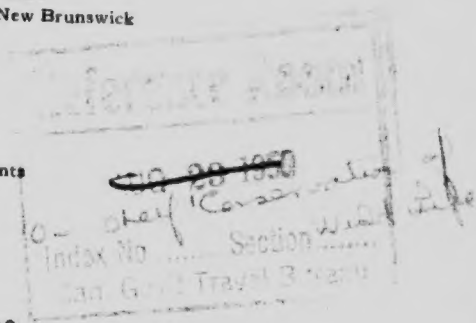
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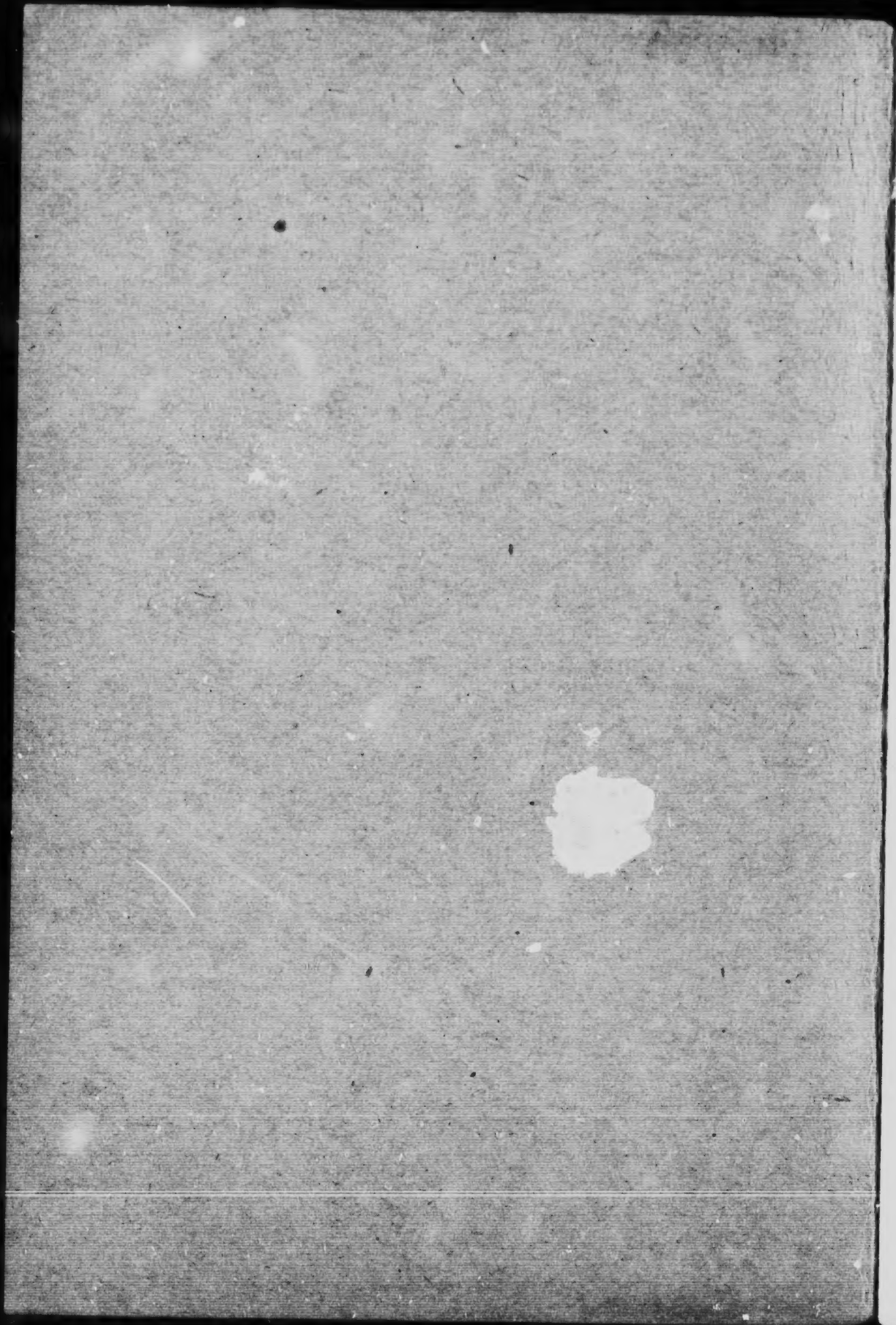
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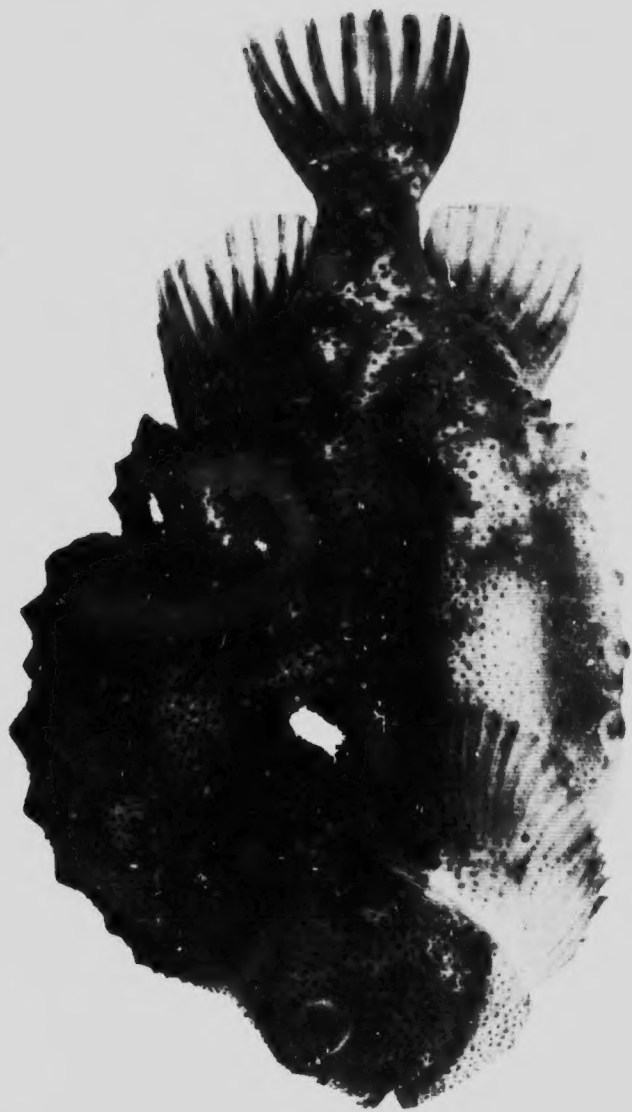


Fig. 1. Adult Lamp-fish. (*Cyclopterus lumpus*).

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WITH 15 FIGURES



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THOMAS MULVEY

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1920

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ITS NAMES IN OTHER LANDS.

THE fish, shown in the frontispiece (fig. 1), is rarely seen in the markets of Canada or of the United States, and few people, except those living on the seashore or visiting there occasionally, will be able to recognize it. Though many of the graceful lines and features of most fishes are wanting, yet is it a striking and attractive object which never fails to excite the curiosity of the observer.

In its wide range it is known under a variety of names. The short, thick, and blunt body has earned for it the title "Lumpfish," the common name in English-speaking countries. "Lumpsucker" is often heard also, in allusion to its habit of clinging to stones or other objects by means of the sucker, a round shallow depression on the under side of the chest, formed by a singular modification of the ventral fins. So firmly can it attach itself to any object that a pail of water, into which one is put and to the bottom of which it has fixed the sucker, may be lifted by seizing the fish.

The crest-like hump recalls the cock's comb and is responsible for some of the names heard in Scotland and the north of England—Paddle-cock and Paidle-cock; the male is called the Cock-Paidle or Red Paidle, and the female the Hen-Paidle or Blue Paidle. It is there also known as the Sea Owl.

Poule-de-mer (Sea Hen) is in use among the Acadians, and the French of Quebec call it "Poule d'eau" (Water Hen), which in the modified form "Henfish" is the common name along the coasts of Chaleur Bay and Miramichi Bay. In France it is called "Lomp," and the Dutch, and, to a certain extent also the English, call it briefly the "Lump." In Germany it is known in the fish trade as the "Sea-bare," and one of the Danish names is Hafpadde or Sea-toad.

As this fish has many excellent qualities as a food-fish and is certain to be utilized on a large scale in Canada in the near future, it seems desirable to have it called by one name only, and none is more simple and less open to objection than lumpfish.

DESCRIPTION.

The lumpfish, like its near relatives the sculpins, has a tadpole-shaped body, which, instead of with scales, is covered with hard, wart-like tubercles of various sizes. The large ones are disposed in seven

rows, one along the middle line of the back, where it appears in fig. 2 surmounting the hump; two along each side, and one on each edge of the flattened ventral surface. In addition the whole body, head, and fins are thickly covered with fine tubercles, so that the fish feels very

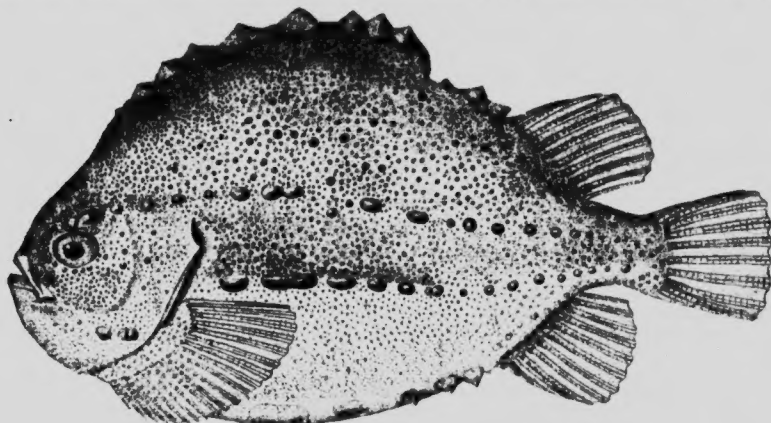


Fig. 2.

Figs. 1 and 2. Adult Lump-fish. (*Cyclopterus lumpus*)

rough to the touch. Behind the hump can be seen a dorsal fin of the ordinary shape, but when the fish was young (fig. 7) another fin was to be seen where the hump is now; this fin, however, becoming covered by the rising hump and at last not being seen at all. The hump results not from the upward growth of the flesh, but is due to an enormous thickening of the skin, which is mostly made of soft cartilage almost gelatinous in consistency. The head is short and very blunt, and the pectoral and tail fins are large, with wide bases.

The skeleton is not made of true bone but of hardened or calcified cartilage, and all its parts as well as the skull can be easily cut. The joints of the backbone are not all of the same length, long and short ones being mixed in the series. The teeth are numerous but weak, and are confined to the jaws. The shape and structure are those of a fish of sluggish habits, which does not range far, and which feeds on small and weak animals. It passes the greater part of the year on or near rocky bottoms, or concealed among floating masses of seaweed, where its favourite food likely occurs in abundance. It reaches a length of two feet and a weight of from sixteen to twenty pounds, but the great majority average much less.

GENERAL DISTRIBUTION.

It is found in the shore waters of North America from Greenland to New Jersey, and occurs also in Hudson bay. The most northern record is Isle Disko, lat. 70° N., and its most southern, lat. 37° N. On

the eastern side of the Atlantic it seldom occurs below 45° N. L., but extends its range north to the White sea and Spitzbergen, and across

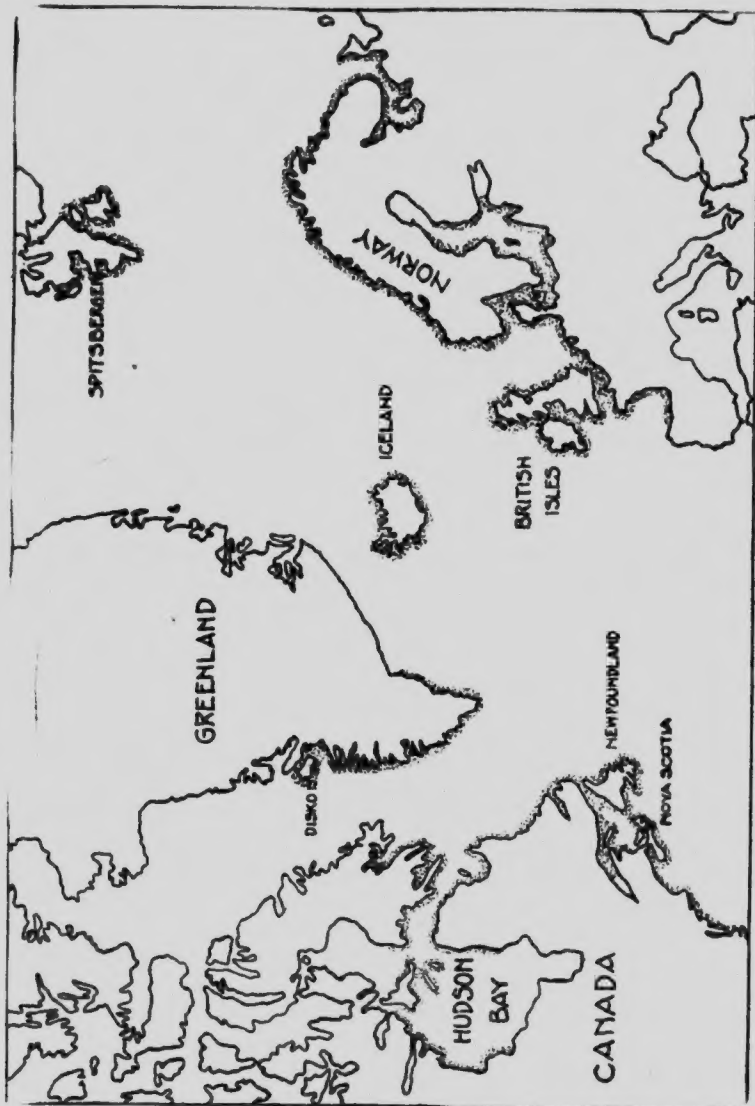


Fig. 3. Chart showing distribution of Lumpfish in North Atlantic, North Sea, Greenland, etc. (Indicated by dotted zone)

to Iceland, as is shown in fig. 3. As the lumpfish is a lover of cold water, its greater southward range on the American side is due to the

influence of arctic currents, setting down along our coast and lowering the temperature of the shore waters.

Does the lumpfish live at great depths for any portion of the year? This can be answered only by saying that all the facts and records of occurrence point the other way, and seem to make it highly probable that it never wanders far from the coast nor into very deep water. The *Challenger* Expedition did not find it beyond the 100-fathom limit, but on the other hand it occurs off the coast of Norway in from 150 to 200 fathoms, where the coast is bold and the water deepens rapidly. It has often been met with some miles off the Atlantic coast of Nova Scotia and in the mouth of the Bay of Fundy, but on such occasions it was living among floating masses of seaweed which had drifted from the shore. In such situations it probably never descends to the bottom. The Biological Station party, working at and off Cheticamp on the gulf shore of northern Cape Breton, in the summer of 1917, found no lumpfish on any of the cod grounds, where the water ranges in depth from twenty to less than fifty fathoms. The stomachs of hundreds of cod were examined, but no lumpfish remains were seen, which seems to show that they do not go so far seaward, for the cod is a voracious fish, feeding greedily on a great variety of animals, and were lumpfish present they would most likely be an item in its bill of fare. It is just possible that they penetrate the deeper and more offshore waters as winter advances, and may even in some places along our coasts reach a depth as great as that recorded at Norway, yet most of the facts so far noticed would seem to confirm the general belief that the lumpfish is a denizen of shore and offshore waters, seldom wandering far seaward or descending to any great depth.

DISTRIBUTION IN CANADIAN WATERS.

The lumpfish is quite abundant in the lower part of the Bay of Fundy in spring, summer and autumn; but seems to disappear when winter begins, at least no adult fish have been taken by the staff of the Marine Biological Station of St. Andrews during the extensive winter operations of the last two or three years. Two young fish, barely two inches long, were captured at Grand Manan in December, 1917—a solitary record bringing vividly before us the general fact that the fish are not then in their usual summer haunts. As a summer resort the Bay of Fundy seems an attractive place, well conditioned to the requirements and habits of the lumpfish. The temperature is low, the shores rocky and everywhere overgrown with seaweeds, which are covered and laid bare in turn by the great tides for which the bay is famous, and in addition the salinity of the water is fairly high. Here it finds ready concealment from enemies, numerous sheltered nooks and

corners for spawning purposes, and an abundance of food, for these submarine meadows teem with invertebrate life of many kinds. It is also very common around the islands in Passamaquoddy bay and in the

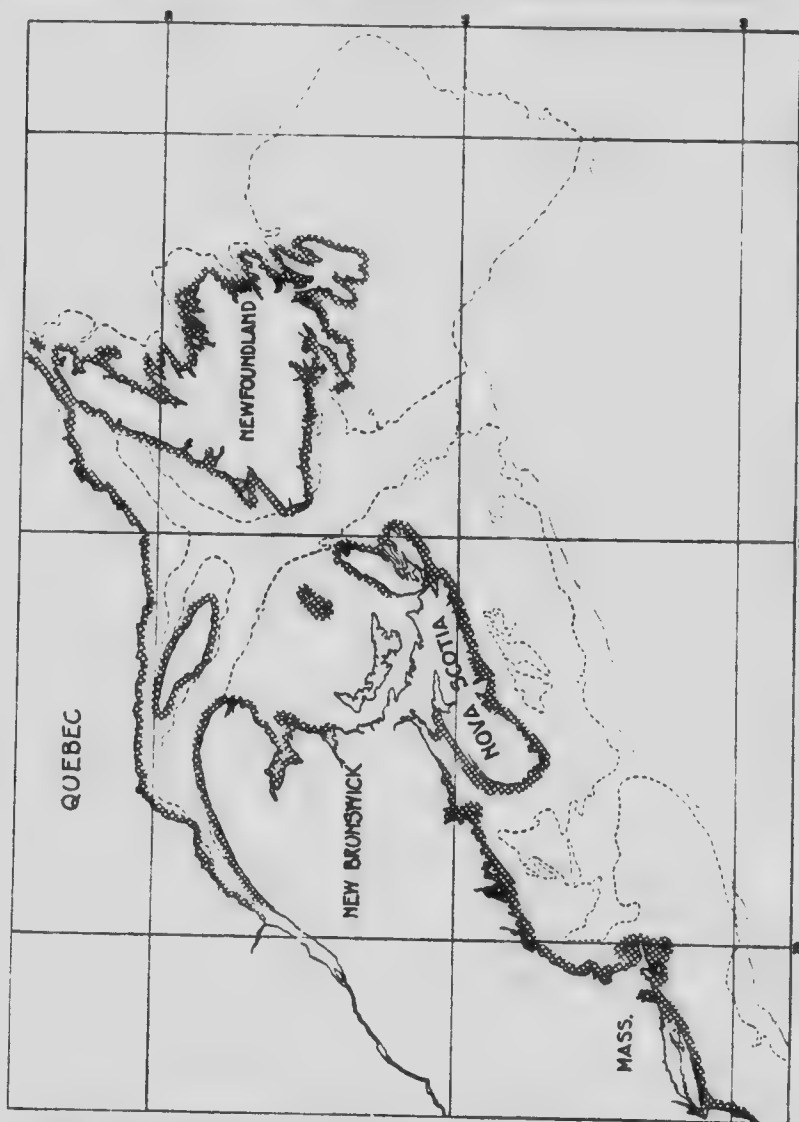


Fig. 4. Chart showing the distribution of the Lur 3-fish along the Canadian, Newfoundlander, and adjacent United States shores (indicated by the cross-hatched zone)

channels and passages between them, but does not seem to wander far up the Bay of Fundy, being exceedingly rare in St. John harbour,

although less so on the other or Nova Scotian side. The lower salinity of the upper part of the bay, due to the large volume of fresh water entering it, may be the cause of its exclusion from that area.

There are numerous records for the Atlantic coast of Nova Scotia from the mouth of the Bay of Fundy to Scatari island at the eastern end of Cape Breton. Wherever salmon nets or haddock traps are used in those waters, lumpfish are captured, sometimes in great numbers, as they are approaching the shore to spawn in May and June. Many are caught in the vicinity of Halifax harbour, weighing five pounds or more apiece, and were formerly used for food, but not to any extent of late years. Many American scientific men, too, have collected it in the shore and offshore waters of the province and regarded it as quite abundant. Indeed we have every reason for believing that a great lumpfish fishery could be carried on there, and the local and other markets supplied with a food-fish, which is consumed in enormous quantities by Europeans and regarded as one of the most nourishing and delicious of food-fishes.

Between Scatari island and Cape North it is very abundant, and reaches a large size, as fishermen report examples over two feet long and weighing from twelve to sixteen pounds. As soon as the salmon nets and haddock traps are put out, lumpfish are swarming in the shore waters, and from 200 to 400 are sometimes found in a single net. They are all mature (either spawning or about to spawn), are of a good size, as these nets retain only the large ones, and in prime condition, especially the males, which are said to have firmer flesh than the females. As the Canadian public knows nothing of it, and the fish is, for this reason, seldom seen on the market, no use is made of them. They are regarded by the fishermen as a nuisance to be dumped out, or carried to the shore and used as a fertilizer. At Neil harbour, White Point and other stations at Aspy bay, fishermen report them very plentiful in the spring.

It is also pretty well distributed in the gulf of St. Lawrence, except in the extreme southern part, where it is rare, due doubtless to the shallow, warm, and less saline character of the water, for this fish is a lover of cool water of average salinity. All along the gulf shore of Cape Breton from Cape North to Mulgrave the lumpfish is well known and is called by its Acadian name Poule-de-Mer, by which it is also known in the Magdalens, where it occurs. It seems exceptionally abundant at Cheticamp, Margaree and Port Hood, which will become important centres of trade in this commodity, when our people begin to realize the worth of the lumpfish as a cheap article of food, and a demand for it arises.

It is also widely distributed in the northern part of the gulf, including Chaleur bay and the lower St. Lawrence as far up as Trois Pistoles. Great numbers are taken every spring at Shippegan island and on both sides of Chaleur bay as far up as Campbellton, where it is

becoming a favourite food-fish. It is reported from Bras d'Or, on the coast of Labrador, and the writer examined a specimen from Hudson bay.

It is thus seen that the lumpfish is very widely distributed and occupies an enormous range. Exceptional local conditions may exclude it from a limited coast area here and there, but throughout the vast region it frequents there are many stations where it is remarkably abundant, and whence unlimited supplies could be obtained for market consumption, were Canadian fish-eaters led to abandon false prejudices and accept on its merits this rich and finely-flavoured fish.

WHERE IT LIVES AT DIFFERENT TIMES OF THE YEAR.

It is always found about the shore in the spring and first part of the summer when spawning takes place, but whether it migrates thither from deep offshore waters or not, is not, as was said, definitely known. Whenever any shore fishery begins, as for instance the salmon or haddock fishery, the lumpfish is already present in considerable numbers and has probably come in some time previously, for spawning is well under way. The reproductive season lasts two months or more on our coasts, and fresh arrivals are of daily occurrence during that time, so that a profitable fishing season would cover ordinarily two months at least. This would probably be the limit in the gulf, where ice conditions delay the opening of the fishing season till the first of May or even later, and most of the lumpfish have moved offshore and disappeared by the middle of July, as our observations in the gulf showed. On the Atlantic and Bay of Fundy coasts fishing would begin earlier.

The movements and whereabouts of the lumpfish after spawning is over are not well known, and seem to depend much on local conditions. In the Bay of Fundy it remains all summer and well into autumn, not apparently living the life of a bottom fish, which it is generally believed to be, but as a pelagic form, drifting about among the masses of seaweed and other debris, which are so common a feature of those waters. All stages are represented, from the tiny larvæ of the season just freed from the egg and not more than one-quarter of an inch long, to large individuals a foot or more in length. The situation is an ideal one, for it combines shelter, an abundance of food, and congenial temperature conditions. Wherever the floating masses occur, it has been observed that the lumpfish occupies them, whether in the Bay of Fundy, along the New England coast, or in the Greenland seas. It will likely be found living under similar conditions along some portions of the Atlantic coast of Nova Scotia. The generally shallow waters of the gulf, absence of bold, rocky shores and of high tides and strong currents are not conducive to the formation of such surface accumulations, and no lumpfish, larger than the fry of the first or second year, are met with

on or near the surface. During the summer, the Cheticamp-Magdalen biological expedition of 1917 got but one specimen at the surface which was larger than the larvæ of the season. It was one and one-third inches long, and was found adhering to the buoy of a lobster trap at Cheticamp island. Fishermen occasionally meet with them in such situations. Where were the larger lumpfish? All the large spawning fish, so common during the first part of the summer, had disappeared by the middle of July and were not seen again. They are not found on the cod banks, as we have seen, and it is very unlikely that fish of their structure and with special provisions for living at the bottom or among floating débris, will resort to intermediate depths. It is strange, too, that none between one and one-third and eleven inches in length were obtained, and fishermen remark that such intermediate sizes are seldom seen. Investigations made in Scotland render it highly probable that maturity is reached when the fish are about ten inches long, but a specimen from the Bay of Fundy, examined by us, was nearly mature at half that length. It seems likely that in the gulf the lumpfish remain permanently on certain offshore grounds until ready to spawn, and then, and then only, resort to the shore waters. Researches carried on in the Baltic would tend to show that large and small fish do not consort to any extent, and the same may be true in our gulf waters, but of this we know little or nothing. For several centuries this fish has been observed and studied more or less, yet we are still ignorant of much of its life-history, especially of certain habits and movements, a knowledge of which would be of much value to fishermen. Most animals have their special haunts and feeding grounds which afford suitable conditions for living and reproducing their kinds, and the lumpfish is probably no exception to the rule. In every large body of water there are certain areas of rough bottom, overgrown with sea moss and weeds, where the small animals on which it feeds are abundant, and where it finds easy concealment from enemies and a medium suitable in pressure, salinity and temperature. We found many such areas in the gulf, but did not succeed in taking lumpfish of any size other than of the tiny fry of the season, but our failure may have been due, not to their absence, but to the small size of our tow nets and dredges, which seldom take large and alert fishes.

It is only when stimulated by the desire to deposit its eggs, that the lumpfish forsakes its congenial haunts and visits the shore, returning when spawning and other parental duties are over.

FOOD.

The general absence of food from the stomachs of the great majority of lumpfish examined has often been noticed, and all sorts of explanations offered. It must be borne in mind that nearly all these

fish were taken on the spawning grounds or in their vicinity, and experience shows that few, if any, fish feed under similar conditions. It is a period of excitement when the instincts, impulses, and energies are at tension and directed to another object. The salmon, on a similar errand, may remain two or three months in a river, and seldom or never take any food during that time, at least the stomach is always found empty. Lumpfish captured at other times are shown to be voracious feeders.

The structure of the mouth and its weak teeth show that it must feed on small and weak creatures, and jelly-fish, worms, and different kinds of small crustaceans seem to make up the bulk of its food. The stomachs of those we obtained at Cheticamp were entirely empty or contained water, or a small quantity of milky fluid, which latter was the digested product of food, for under microscopic examination it showed small fragments of crustaceans. In the stomach of one from Passamaquoddy bay taken on September 4, several invertebrates were seen, among them a small jelly-fish and some amphipods. Another taken at the same place, September 7, was gorged with a delicate little crustacean, belonging to the genus *Caprella*, which is generally very abundant among sea moss and other bottom growths. The lumpfish is said to prey also upon small mollusks, fry of the herring and sand-eel, shrimp and marine annelids or worms. It has been caught on fish trawls at Iceland, and by line men fishing for pollack at Canso, N.S. This would seem to mean that its food does not always consist of small organisms, but at times of bulky ones.

THE SEASON AND MANNER OF SPAWNING.

Some observers report that the lumpfish spawn on the New England coast in March or April; others, and for the same locality, in May and June. While the season may differ a little from year to year, it is undoubtedly a long one, and likely lasts from April till June. In the North sea, and in the Cattegat and Baltic it begins in January and lasts till June. No exact dates are available as to the opening of the season in the Bay of Fundy, the gulf, or on the Atlantic coast of Nova Scotia, but whenever the weather conditions are suitable for salmon and haddock fishing to begin in the gulf, the lumpfish are inshore, and spawning is under way. This is from the 20th of May to the 1st of June. The spawning was over at Cheticamp, Cape Breton, when we began our investigations there on June 12, and all female fish had left the shore waters, as only large spent males were collected subsequently. The latter always remain to guard the egg masses until hatching is completed. On June 27 we secured our first larval lumpfish which were six millimetres or one-quarter of an inch in length, and the eggs from which they came must have been deposited two months previously, for

it has been clearly shown that in the first of the season from fifty to seventy days are required to hatch out the young. That would make the beginning of the season as early as the middle of April, and it probably was earlier, for these larvae were larger than others subsequently taken and so must have been some days old when captured. We are therefore safe in concluding that in the gulf at least the spawning begins in April and ends in June, but what the period is in the Bay of Fundy or along the coast of Nova Scotia cannot be fixed, for data are wanting.

The sexes are easily distinguished at this time, for the male is richly coloured, being pink or red, especially on the under surface, the lower part of the sides, and on the disk and chin. The pectoral and caudal fins are often beautifully streaked with scarlet. The females vary from olive-green to blue-black, paler on the lower surface, and with greenish pectorals. After spawning the brightness of the nuptial hue is gradually lost by both, and the males assume in time the dull colouration of the female.

It is also said that the male fish are smaller than the females. Of seventy taken in a salmon net in Scotland, forty were females with an average length of 40 cm. (16 inches) and weight of 6 pounds 6 ounces; thirty were males, average length 28 cm. (11 inches) and weight, 1 pound 14 ounces. We examined seven specimens, all males, at Cheticamp, July 7, which had been taken from a salmon net, and found the average length was 32.4 cm. (13 inches), and average weight 2 pounds 11 ounces. Only one female, length 33 cm. (13 inches), was seen during the summer. Fishermen say they often take females weighing 12 pounds or more.

The favourite spawning grounds are rocky shores overgrown with tangle and other seaweeds where the eggs are deposited in masses at points below low tide. It was formerly thought that nests were made after the manner of the sticklebacks or by scooping out depressions in the sand, but a closer and more careful study of the operation goes to disprove this idea. The egg clusters are from 5 to 7 inches in diameter and the eggs adhere not only to the object on which they are laid, but to one another by means of sticky flaps or facets, and in such a way that the ball takes on the character of a sponge and is easily penetrated by the water (See fig. 5). As a fish's eggs will not hatch unless water containing oxygen is kept flowing pretty regularly over and among them, the spongelike nature of the mass is a great aid in this direction, and, if the tide should fall low enough to expose them to the danger of drying, enough water is retained to keep them moist till covered by the next tide. The hatching of the largest number of eggs is made possible also by the habit of laying the eggs in several small clusters which are more easily penetrated by, and kept supplied with new water rich in



Fig. 3. Mass of Lampfish eggs deposited amongst rocks.

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oxygen. The number of eggs produced by one fish will depend on its size, and is found to vary from 80,000 to 400,000, the weight of the ova sometimes being fully one-third of that of the whole fish.

When oviposition is over, the female deserts the spawning grounds, and retires offshore, for seldom is one taken in salmon nets in the gulf after that, but the male remains and guards the egg masses through a very long period of incubation, driving away any enemy that approaches, and pressing the clusters with his snout, which helps the water to pass out and in through the many little pores and channels, which must aid the hatching process considerably. He also fans the eggs with the large pectoral fins and forces water from his mouth through the mass; yet in spite of all these devices and his constant attention, complete aeration of the ova is not effected. Much of the spawn does not hatch, and storms tear the clusters from the rocks or seaweed, and cast them out upon the beach where they perish. Fishes, crabs, and birds must destroy much of it, and some of the eggs are not fertilized during oviposition. We examined a mass found on the twenty-ninth day of June cast upon the beach at Cheticamp, and found that many had escaped fertilization and were quite clear, and that others contained dead embryos, while the outside of the mass was composed of empty capsules from which the young had escaped.

Some old writers were fond of picturing the male watching over the young for a time, and carrying about many thousands of his tiny progeny clinging to his body by means of the suckers. It was a pleasing conceit, but late observers have never met with the peripatetic nursery.

While on duty guarding the eggs, he is said to be very bold and fearless, dashing out and attacking anything coming near, even the formidable wolf-fish. Fabricius, generally regarded as a reliable authority, writing in 1780, declares he had seen a wolf-fish actually worried to death by one; and other instances of his great courage are on record. He has been seen to pick up a crab that had crept near the eggs, carry it off to a safe distance and drop it. As the spawn is usually placed among red, brown or yellow rock weed, the parent fish is not easily seen, and his sudden and unexpected dash is enough to frighten enemies away.

By the time his parental duties are ended and he begins to move into deep water, the brilliant hues have faded, and the back and sides soon take on a dull olive or blue colour.

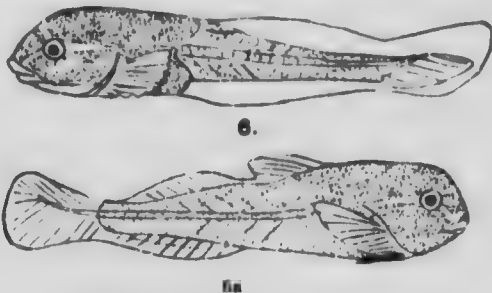
THE EGGS AND THE YOUNG.

The eggs are pale red or sometimes quite pinkish, and are not all of the same size, but vary from one-eighth to one-tenth of an inch in diameter. Looking at them through a microscope one sees several little oil globules in each, which gradually run into one as the hatching

proceeds, and the droplet later becomes inclosed within the body of the tiny embryo, where it can be seen as a golden spot for some days after the larva has escaped from the egg membrane.

The length of time for hatching depends on the temperature and, to a certain extent, also, on the kind of circulation of water maintained; for, unless the eggs are well exposed to water containing plenty of oxygen and renewed at intervals, many will never hatch, as we have already seen. Experiments have been made in hatching them artificially in tanks, but many eggs go "bad," due doubtless to an insufficiency of oxygen.

In the North sea a period of about sixty days is needed at the beginning of the season, when the water is cold; later on less time is required, and towards the close of the season it is said the eggs will hatch in fourteen days. It is not known what time is needed in Canadian waters, but it is probably about the same. What the larva is like when it escapes from the egg can be seen from fig. 6. The smallest



Stages of young Lump-fish.
6. Specimen. 5.5 mm. long, June 29, 1917.
6a. Specimen. 8 mm. long, July 13, 1917.

we collected was 5.5 mm. long, barely one-fifth of an inch, and dead embryos, which we took from eggs found on the beach, were about the same length. American writers give the length on the New England coast as less, namely from 4 to 5 mm. In the North sea they are larger, running from 6 to 7 mm. or even more. It is likely that the size at birth depends a good deal upon the size of the egg and upon the length of time in hatching. The period may be shorter in the waters to the south of us than in ours, while ours is likely briefer than that in the North sea.

Looking at fig. 6, it is seen that the young lumpfish, like others at that age, has a continuous fin along the middle line of the back, around the tail, and on the under side as far forward as the vent. The other fins, the pectoral, are very small and rudimentary. No ventral fins are seen. They are situated under the throat, and never grow to be real fins, but develop into the sucker already referred to. At birth the

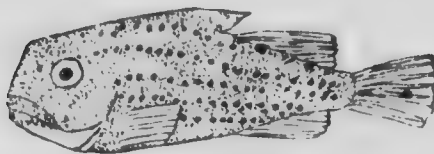
young lumpfish has the sucker well formed, and can use it to fasten itself to eel grass, or any other suitable object, when it needs rest, or to help it to escape its enemies. By this means also they attach themselves to seaweed or any drift material and are carried out to sea and distributed over large areas of feeding ground. As swarms are liberated at the same place, the necessity for such a movement is evident, and hence the disk is a very useful and valuable possession.

The median continuous fin soon begins to break up and outline the future permanent ones. Examples from 6 to 7 mm. long show the two dorsal fins still connected by a strip of membrane, and also with the caudal, while the latter and the anal are similarly joined. In samples 8 mm. long (fig. 7), all the fins are nearly complete, and at 9 mm. entirely so. In the meantime rays, or rod supports for the membranes, are seen growing in all these as well as in the pectorals which are well formed by this time. European writers tell us that this stage is reached in their waters when the fish are from 10 to 12 mm. in length, and American authors give about the same length. The transformation may depend more upon age than upon size, but, as accurate observations have seldom been made, little can be said on the matter.

The colour of the young at first is a yellowish-green, with a slight brassy lustre and with lighter streaks, and patches occur of a silvery sheen. The head, pectoral fin, and the base of the tail fin are dotted with dark spots and many of these are star-like or stellate in pattern. As the fins grow and become separate, the pigmentation or colouring increases, and a great many of these secondary colour cells take the colour of the rock-weed, eel-grass, or other objects among which the fish are found, orange, brown and bright green being the usual tints. There is generally an unpigmented band between the eyes, and another occurs on each side of the head from the snout to the gill opening (fig. 7).



7.



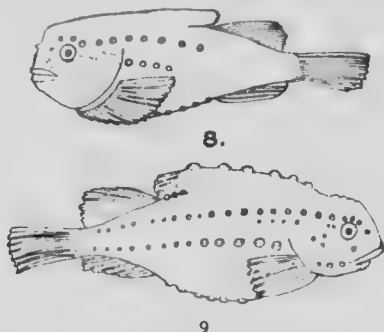
7a

7. Specimen. 18 mm. long, showing peculiar colour pattern, Passamaquoddy Bay.

7a. Specimen. 18 mm. long, showing peculiar colour pattern, Passamaquoddy Bay.

Both are often to be seen in specimens 14 mm. or three-fifths of an inch long, though they are mostly larval characters and soon lost.

We have seen that the adult lumpfish is covered with wart-like tubercles, large and small, and that the largest are arranged in serial order, along the middle line of the back, down the sides, and along the edges of the somewhat flattened under surface. The larval fish at birth, and for a long time after, is very smooth, and there is no appearance of tubercles until it is about 18 mm. (three-quarters of an inch) long, when a few tiny ones are to be seen above and behind the eye; subsequently the increase in number and size is rapid. When the young fish is 22 mm. long (fig. 8), the two side rows, beginning at the head, have reached the



8. Specimen. 22 mm. long, showing papillæ or tubercles, September 8, 1917.
9. Specimen. 32 mm. long, with series of tubercles complete, Grand Manan, September 20, 1917.

middle of the body, and the ventral row consists of flattened papillæ. At 25 mm. (one inch), the upper lateral series is complete, extending to the base of the tail fin, the second one has not reached that point, and the dorsal row is just evident behind the head. At 32 mm. (one and one-quarter inches), all the series are complete and numerous small tubercles and other asperities are scattered thickly over the body (See fig. 9). The larger tubercles are surmounted by spines, which are more or less serrate and frequently hooked backwards, a feature well marked in fig. 10, which is drawn from a fish 33 mm. long and a little over one year old. Comparisons between the larvæ in our waters and those observed farther south along the Atlantic coast, as well as those of the North sea, show that the stage of full armature is reached in our waters at a smaller size than elsewhere.

DISPERSAL AND HABITS OF THE YOUNG.

The larvæ were found at all depths from the shore to 92 metres (300 feet), and to a distance of four miles off the coast, but the extent of the offshore distribution seemed to depend a good deal upon the kind of bottom and the depth of the immediate shore waters. Where the bottom

was rocky and the shore water fairly deep, the zone of distribution was narrow; where opposite conditions were found, the dispersal was offshore. The former is, to a large extent, the case in the Bay of Fundy and Passamaquoddy bay, although the young fish there are often carried seaward among drift material, but in the gulf there is a noticeable lack of floating seaweed or other débris to help in the movement. It was then a matter of some interest to find larvæ, newly hatched and about 5.5 mm. long, among the plankton 2½ miles from land in June, and more of the same size on July 4, 4 miles from the nearest land. In the absence of drift material, there must be other means of sowing the helpless but living seed so far from the supposed hatching grounds - surface currents due to winds and tides, or a possible extension of the hatching grounds seaward where the shore waters are shallow and bottom smooth or otherwise unsuitable for oviposition and hatching. These tiny creatures had very recently been released from the egg for they had the unmodified fin; and it is hard to understand by what means they made a journey of 4 miles in the open sea, had they been born at the shore. It is possible they were released from the egg in the vicinity of the place where they were captured. The late date would point to hatching under poor conditions of temperature and light. Indeed many of the smallest larvæ we secured were taken in deep water and at long distances from the coast.

In the daytime they are found at the surface and very few if any below, as towings made at the same time showed. At night they left the upper waters and were then found at or near the bottom. After July none were collected at the surface, and few at the bottom, and as the temperature of the surface waters had by that time risen to 15° C. (56° F.), it was thought to account for their disappearance, yet the young lumpfish can bear a higher temperature and thrive in it. On August 18, at House harbour, Magdalen islands, we took two specimens 15 and 17 mm. long, the largest that had been seen up to that date, among eel-grass in a foot of water at 22° C., or 72° F. They are found at the surface in August off the coasts of southern New England, where the surface temperature must be even higher than that of the gulf in July, when they disappear. The life history of the lumpfish in the gulf is peculiar and is far from being fully understood.

In Passamaquoddy bay the young are met with all summer among drifting rock weed, but the surface temperature seldom rises above 9° or 10° C. On September 8, at Wilson's Beach, Campobello island, we collected eight specimens, ranging from 18 to 23 mm., with a hand-scoop, from a boat moored to a quay. They were zigzagging and doubling under and among fragments of red and brown alga, whose colours were blended in their own colouration. They did not appear to rely on this, as some think, to escape notice, but invariably made use of their muscles and fins to escape from danger. They were surprisingly

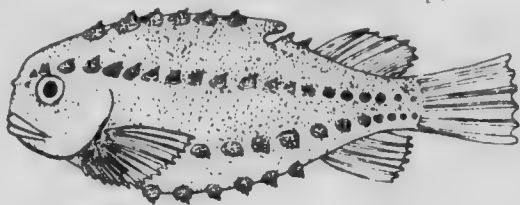
active and wary, so that fully half of those coming within reach were missed. A slowly moving tow-net of the usual size must have failed to catch any except by the merest chance. This may throw some light on our failure to collect them, either at the surface or, except on one occasion, at the bottom, off Cape Breton, after the middle of July. By that time they had nearly doubled the larval length and were stronger, more alert and with keener senses, the result of a larger experience and knowledge of their surroundings. Larger nets, moving more rapidly, might have told a different story, for in the North sea, where the lumpfish has been carefully studied, the young have been found at the surface all the year. Indeed it is doubtful if it becomes at all localized during the first year, but rather leads a planktonic life, drifting around in the tides and currents. Some even think that the young congregate in schools when they have reached a certain size, but we saw no evidence of this in the gulf, unless the large and exceptional haul of twenty-nine individuals, taken one mile off Cheticamp, indicated the presence of a drift swarm.

THE RATE OF GROWTH.

The lumpfish is said to grow to be over two feet long, and to weigh from 12 to 20 pounds; but such large fish are seldom caught, the average size being a little over a foot in length and the weight from 3 to 5 pounds. The young seem to make a pretty rapid growth during the first summer, sometimes doubling the average length in a month; but there are some reasons for believing that little increase is made during the winter, especially in the gulf, when ice forms over the greater part of it and chills the water to such an extent as to weaken the vital processes.

We collected larvæ on July 13 that averaged 7.6 mm. in length, and a month later two taken at House harbour averaged 16 mm., and some at Cheticamp 17 mm. in length. It is seen that they doubled the average length in a month. Earlier in the season, while the larvæ are tiny and weak, and food conditions not so good, the growth is much slower, but it is a hard matter to calculate it correctly for there is always a number of very small ones mixed with others perhaps twice their size. This is due to the long spawning period during which some larvæ are freed from the egg even before oviposition is over, and thus the earlier become mixed with the later ones. On September 8 the fry taken at Wilson's beach, Campobello island, averaged about 22 mm. It is thus seen that the relative size and rate of growth in the gulf and in Passamaquoddy bay do not differ much during the summer, but in winter there appears to be a greater arrest of development in the former than in the latter, probably due to the presence of ice in the gulf. On July 7 we got a specimen 33 mm. (one and one-third inches) long

(fig. 10) adhering to the buoy of a lobster trap in six fathoms off the southwest point of Cheticamp island, which was certainly a year old at least, for its size, adult appearance, and full equipment of strong tubercles marked it off sharply from the season's fry.



10

10. Specimen. 33 mm. long. S.W. Point, Cheticamp Island, in 6 fathoms. July, 7, 1917.

Two were collected at Grand Manan, December 12, 41 and 45 mm. long respectively, which were evidently the young of that year. Thus in three months the growth doubled in that locality. If the 33 mm. one is a fair representative of the size attained in the gulf the first year, it is only a little more than half that reached in the mouth of the Bay of Fundy and in adjacent waters. As we have seen, there is very little difference during the summer months and hence growth must continue during autumn and early winter at least, in the latter place, while it slows down and practically ceases in the former. This contrast has been noticed in the case of other fishes, and is very marked in the Canadian plaice. A lumpfish was taken at Barrington passage in the mouth of the Bay of Fundy in June, 1910, which was 55 mm., or one and two-third times the size of the Cheticamp example of the same age.

Some writers think that the lumpfish is a very slow grower, and that large ones of two or more feet in length and weighing from 12 to 20 pounds must be very old. It is likely true of some regions but not of all. A fish, suited to a certain range, will be found to shade off and become less vigorous and less numerous as it recedes north or south from where the optimum or best conditions are found. Where open water prevails, and the temperature does not rise too high in the summer or sink too low in the winter, as in the Bay of Fundy and along the Atlantic littoral of Nova Scotia, the lumpfish may make a fairly rapid and uniform growth, as evidenced by the fry being 23 mm. long in August, 43 mm. in December, and 55 mm. in the following June, in and about the mouth of the Bay of Fundy. Along the New England coast, where the summer temperature rises pretty high, it seems to grow more slowly, which is the case also in the lower part of the North sea and the Baltic, where the mature fish average much smaller than farther north. The small size, reached in the gulf of St. Lawrence the first year, is likely followed by an equally slow development at all stages.

By means of certain rings on the scales, the age of most fishes can be found out pretty accurately, but the lumpfish has, instead of scales, peculiar wart-like tubercles, ending generally in spines, not growing like ordinary scales, and, having no known character by which the age of the fish can be told. Similarly the joints of the backbone often show the annual growths by a series of concentric rings on the side of the cup at each end of a joint, but the backbone of the lumpfish is composed of cartilage, somewhat hardened although still not real bone, and the markings are faint, irregular, and difficult to make out. However, by staining and clearing them, we were able to arrive at some general results, which may not be absolutely correct. Fig. 11 is from a specimen 11 cm. ($4\frac{1}{2}$ inches) long and was judged to be in its third year. Fig. 12 is the vertebra of a fish 26 cm. (10 inches) in length

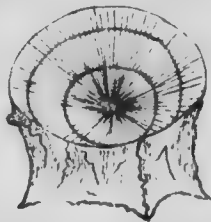


Fig. 11. Vertebra of Lump-fish, 11 c.m. long.
and in its 3rd year. Bay of Fundy.
x 10 M. Anderson.

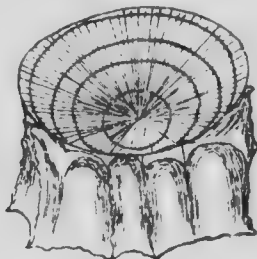


Fig. 12. Vertebra of Lump-fish, 26 c.m. long
and in its 5th year. Campobello,
September 8, 1917. x 4 M. Anderson.

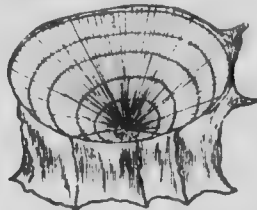


Fig. 13. Vertebra of Lump-fish, 30.6 c.m.
long, and in its 7th year. Chetti-
camp, July 7, 1917. x 5 M. Anderson.

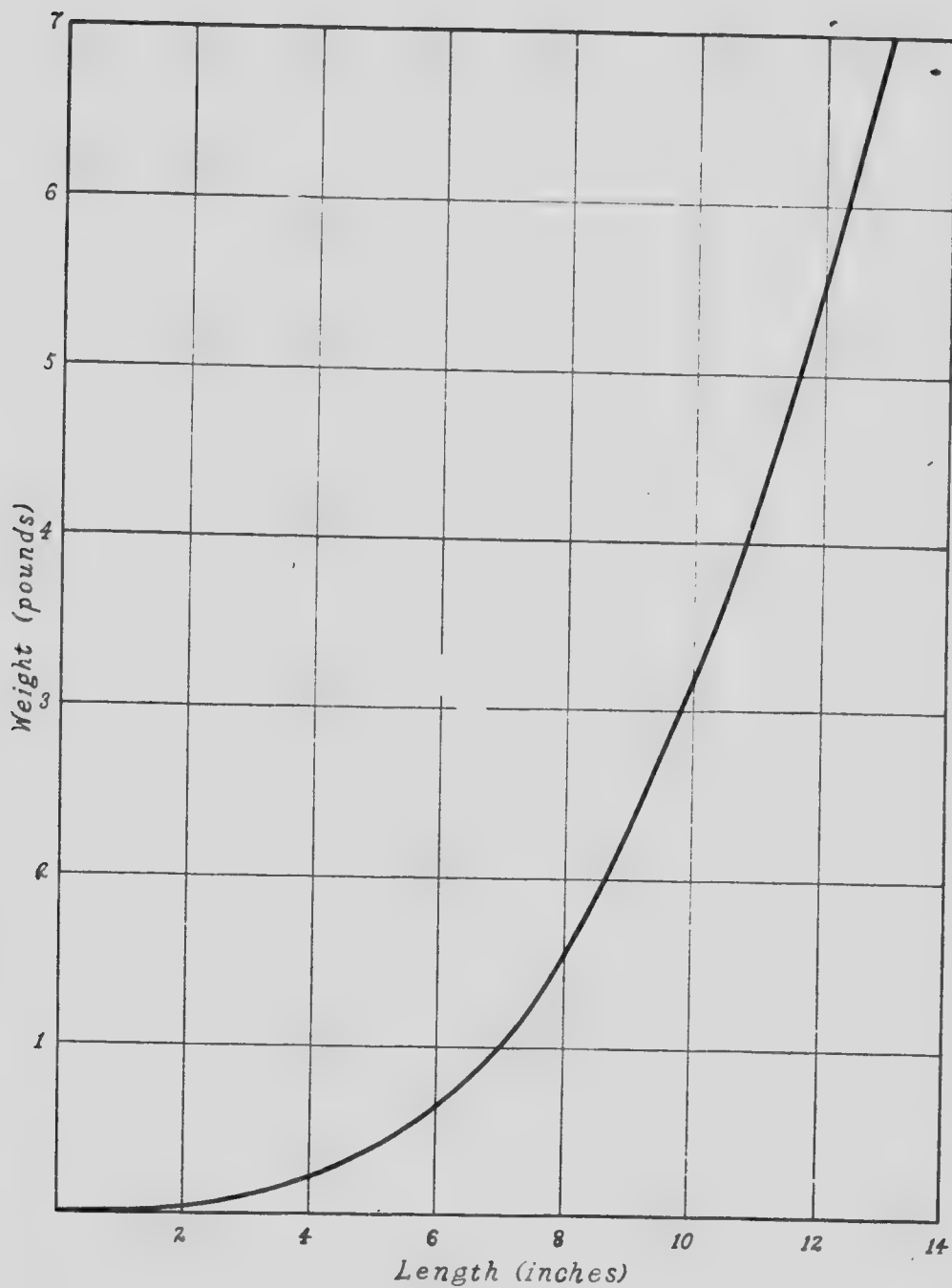


Fig. 14. The Lump-fish. Graph showing the ratio of length to weight

which was apparently in the fifth year, while fig. 13 is drawn from a fish 30.6 cm. (12 inches) long and in it six rings are seen. Another specimen 34 cm. in length showed seven rings. It was a spent male and weighed 3 pounds. When the lumpfish reaches 46 or 47 cm. (19 inches) it is said to weigh 10 pounds. Cape Breton fishermen tell of taking fish over 2 feet long and weighing 20 pounds or more, and they are reported occurring of that size in the northern part of the gulf. The weight increases more rapidly than the length. A fish 7.6 cm. weighed 21.3 grams; another 9.3 cm., 33.6 grams; a third 15 cm., 134 grams; a fourth 30 cm., 1,020 grams; and a fifth 32.5 cm., 1,474 grams (3 lbs. 4 oz.). At this rate of increase a lumpfish 70 cm. long, a size sometimes reported in Europe, would probably weigh 20 pounds or more.

Since the above was written, we have received from Dr. A. G. Huntsman a collection of lumpfish from Passamaquoddy bay made in the autumn of 1918. They ranged in length from 18 to 153 mm. and have furnished the chief data for the construction of the graph shown in fig. 14, which represents the ratio of the length to the weight. The graph confirms the general conclusions already drawn from the study of a limited quantity of material.

It is remarked that in the case of fry between the lengths of 18 and 40 mm., an increase of 5 mm. in the length results in a doubling of the weight, but above 40 mm. the ratio of increase in weight is less. Doubling the length increases the weight from seven- to nine-fold, or approximately the weight varies as the cube of the length, and hence a lumpfish 2 feet in length must weigh from 18 to 20 pounds or more.

QUALITIES AS A FOOD FISH.

With the increase of population, especially in the central provinces of the Dominion, and a growing demand for Canadian food-fishes in the world's markets, coupled with the soaring of the price of foodstuffs to unprecedented heights, the Canadian consumer is becoming more and more interested in every proposition to increase the amount of edible fish and lessen somewhat the cost of living. Prices have doubled, trebled or even quadrupled in a few years; the quantity available for home consumption has continued to shrink as the foreign demand and prices have risen, so that a veritable fish famine is often experienced in our midst.

To relieve this shortage and supply the demand with an article at a moderate price, attention is being turned to the utilization of other and cheaper forms of food-fishes than the staple ones of the trade. Many of these are of excellent quality and in demand among Europeans, where they form no small part of the fish consumed as food and can generally be bought at reasonable rates. The lumpfish is one of them.

As already said, it abounds in the shore waters of the Maritime Provinces where it is taken in considerable quantities in the prosecution of the salmon and haddock fisheries, but is seldom used for food, though it is a rich, tender, well-flavoured, and nourishing fish; and, if put on the market and its merits made known, would soon be in demand. In England and Scotland it is held in high esteem by many and is regarded as second only to the far-famed turbot.

The abundance of the old and well-established food-fishes in our rivers and coast waters which heretofore sold at very reasonable rates, was, in part at least, responsible for our neglect of the lumpfish, cunner and flounder, as well as of other fishes which are largely eaten in Europe. The tastes of a people, too, are apt to run in certain ruts and conform to certain standards, so that one generation easily follows the likes and dislikes of a previous one. It is largely a matter of education. The common sturgeon, one of the best food-fishes in the world perhaps, was, until within a few years, plentiful in the St. John river, New Brunswick, where it reached the length of 10 or 12 feet and the weight of 400 or 500 pounds. The residents along the river looked upon it as something unclean and dangerous. Their parents had held it off at a safe distance; it would be prudent for them to follow the same salutary course and take no risks. And so it went on from generation to generation. The large fish disported daily before their doors, sometimes, too, in the presence of hunger and suffering; and if one happened to be caught in a shad or salmon net, it was thought to be highly honoured if it were towed ashore, boiled and fed to the hogs; generally it was knocked on the head and turned adrift. We grew up in this atmosphere of prejudice, and well remember numerous instances of the kind.

Many years ago, some enterprising American fishermen and fish dealers arrived on the scene and established a sturgeon fishery, which, for some years, netted big profits to all concerned. The fish were shipped to Boston and New York where the article was in demand, and the business grew to be one of the industries of the river. But in a few years it began to decline and the special fishery came to an end. Here was a prime article of food, in value and nourishing quality equal to the salmon, yet was it unutilized for generations. Our attitude towards the lumpfish and others is just as foolish, but the stringency of the times will likely help us in brushing aside these prejudices and setting ourselves right in the matter.

In the Baltic and North sea countries it is one of the staple food-fishes and its consumption is increasing, proving that it must have many good qualities which recommend it to fisheaters. The Icelanders are very fond of it and eat it either fresh or preferably smoked, as it keeps well for a long time when so prepared. The latter, too, is the favourite way of preparing it in Germany as well as in Denmark.

When used fresh, it is generally fried, as boiling is said to injure the flavour. A gentleman, living in Chatham, N.B., informed us lately that he had used it in the spring of 1918 both fresh and salted, and had no hesitation in saying it was one of our very best food-fishes. It was, in his opinion, equal to the salmon in flavour and food value besides being more tender. We had it served at Cheticamp in the summer of 1917, and found it sweet and palatable. For many years, according to writers on this fish, it has been used in Halifax to a limited extent, and more generally along the coasts of Chaleur bay. When its merits as a nourishing food become known, it is certain to be in as great demand in Canada as it is now in Europe.

THE LUMPFISHERY OF EUROPE.

This industry has already been referred to, but a more detailed account of its magnitude and importance may help us to appreciate better our opportunities, and to render it very probable that with effort and business thrift we shall be able to build up a good trade in this commodity. The time is favourable; the unutilized stock is at hand; fish foods are scarce and must continue to be in great demand for some years at high prices; and from a national point of view it is our duty to seek to develop every resource to help to meet the shortage and bear the financial burdens of the country.

At Heligoland, a very small island in the southern part of the North sea and just off the mouth of the Elbe, the lumpfish are simply "gaffed" by the fishermen at low tide, and while they are guarding the eggs. The gaff is simply a short iron hook at the end of a pole, and, armed with this, the fisherman wades along the shore, peering among seaweed or under rocks for the fish; which, when discovered, are easily captured. In this primitive way the fishermen of this little island not only supply their own people with an article of food which is in much demand, but from 1905 to 1908 sold 30,940 pounds to merchants from North sea German ports. These Heligolanders consider the fish a great dainty, and we are informed that the highest prices in Europe are paid there, especially at the beginning of winter when lumpfish are in prime condition. Then prices often range as high as 7½ cents a pound retail for undressed fish, which would be equal to about 18 cents for the dressed article. The price, however, fluctuates, according to the season and the abundance or scarcity of the stock. In May it was, for the year already mentioned, about 3 cents wholesale; in June and July the fish were very plentiful, and large quantities were also brought into Germany by Danish fishermen from the Cattegat and the Sound. Then the lowest values prevailed, two cents or even less; in November the price advanced

to 4 cents, wholesale. To the man in the street these prices seem very low, but they were higher than the fishermen of the Maritime Provinces were receiving for their codfish, beheaded, split, and ready for "striking."

Danish fishermen take large quantities, mostly in the North sea, Cattegat and Sound, but the adjacent parts of the Baltic are also fished, and a considerable stock is brought from distant Iceland. The Danish government classes it as a staple food-fish, and regular statistics of the trade are kept from which the following summary is taken:—

	1903		1904		1905		1906		1907	
	Pounds	Value (\$)	Pounds	Value (\$)	Pounds	Value (\$)	Pounds	Value (\$)	Pounds	Value (\$)
North Sea	597,828	8,021 90	325,611	6,080 93	422,004	7,340 48	532,060	8,710 81	838,530	17,166 21
Cattegat	346,401	4,568 70	216,612	4,057 02	362,670	6,402 00	478,995	7,929 75	818,750	16,194 15
Baltic	240,141	3,171 90	109,065	2,061 25	59,334	1,047 00	52,965	873 00	21,780	706 50
Total	1,184,370	15,762 50	651,288	12,199 20	844,008	14,790 08	1,064,020	17,512 56	1,677,060	34,176 86

SUMMARY FOR 1903-1907.

	Pounds.	Value.
North Sea..	2,716,933	\$ 47,329 35
Cattegat..	2,221,428	39,151 62
Baltic.	483,285	7,950 25
Total.....	5,421,646	\$ 94,431 22

	1906		1907	
	Pounds.	Value	Pounds	Value
North Sea...	454,964	4,975 85	217,775	2,964 32
Cattegat...	14,410	289 84	10,318	126 53
Baltic.....	440,554	4,856 06	203,057	2,443 43
Total.....	909,928	10,121 75	431,150	5,544 28

To fully appreciate the meaning of these figures and the profitable nature of the trade, we must bear in mind that no special fishery for lumpfish is carried on in Danish waters, but all taken are simply the by-products of other fisheries, such as the herring, flounder, mackerel, and salmon, and therefore represent an almost clear profit to the fishermen.

It is seen that the catch in 1907 was large, nearly twice the average for the four preceding years, and prices, too, were the best, averaging over 2 cents per pound wholesale. It is evidently making its way into popular favour. The bulk of the catch is made in the North sea and Cattegat, but that of the Baltic seems declining, due, presumably, to overfishing by Germans and Swedes, whose operations are quite extensive. The figures given do not represent the total of the Danish trade in this fish, which for the year 1907 was from all sources 1,500,000 pounds.

The Swedish Government does not class the lumpfish as a staple food-fish. It is one of the many known on the market as composing "mixed fish," and hence statistics are not available for the whole country; but special records of the catch in Malmohuslan, one of the thirteen Baltic districts, are at hand for 1906 and 1907, and although not complete give us an idea of the big business done in this fish. The aggregate for the two years was at least 1,341,078 pounds, worth \$15,666.03, caught and marketed by the fishermen of one district alone. As fishing is a very common industry along the Swedish littoral the total catch must have amounted to several million pounds and formed no inconsiderable part of the whole fish trade of the thirteen provinces. Altogether a by-product of other fisheries, it means a clear profit to those engaged in the business. Here, in Canada, it is looked upon by fishermen as a nuisance and thousands are destroyed daily, or emptied into the sea from nets and traps during the haddock and early salmon-fishing season. Were a demand for it once created in Canada, fishermen would be anxious to save and bring ashore whatever they caught and prepare them in the most desirable way for shipment.

HOW MARKETING AND USED.

Large quantities are put on the German and Swedish markets smoked, and in this state it is said to keep well and preserve its flavour. It is beheaded, the entrails removed, and the thick skin pulled off, even the belly parts, which are very thin, being cut away. In this way a rather uncanny-looking creature is changed to a round, plump, and pinkish body inviting favourable attention. They are then strung on rods and smoked. The fresh-fish retailer always presents them to his customers cleaned and ready, and the Danish and Swedish fishermen often bring them to German ports prepared in this way.

Fig. 15 shows the skin of the lumpfish to be enormously thickened, especially where it forms a hump on the back and a series of lateral ridges, and it makes up no inconsiderable part of the total weight. The head, however, is short and the entrails not at all bulky so that a good proportion of the fish is choice, edible flesh.

To find what percentage of the total weight the latter represented, we dressed a fish 32 cm. (13 inches) long in the way described, besides

removing all the fins, including the tail, and 40 per cent of the total weight remained. A codfish, dressed in the same way but without the thin belly parts being removed, yielded 50 per cent of edible flesh, showing a slight advantage in this respect, but in all others it is inferior, especially in delicacy and richness. By preparing them in this way, a very considerable saving could be made in the cost of transporting them to the more remote markets.

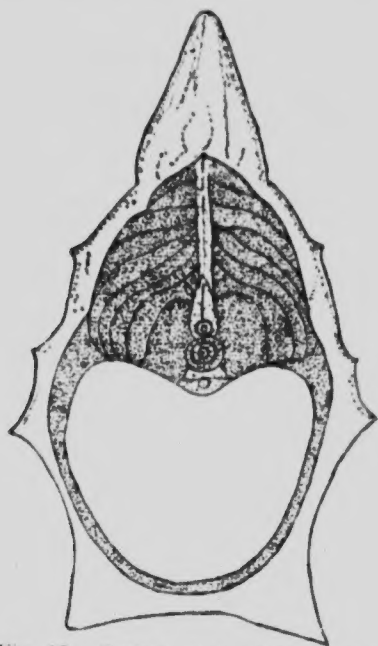


Fig. 15. Cross-section of Lump-fish showing thick skin, lump, and thin body-wall. M. Anderson.

The favourite way of cooking it fresh is by frying or baking, as the delicious flavour and rich, juicy quality are best retained. When smoked and prepared for the table by the usual methods, it is considered excellent. This fish is said, not only to keep well when smoked, but it is also claimed that the distinctive taste and peculiar qualities are preserved best, when it is thus prepared.

SPECIAL FISHERY.

If all the lumpfish were saved which are now caught incidentally in the other fisheries, the total would be surprising, and would likely keep the market well supplied for some years. If, however, a demand should arise which present methods could not meet, the question of

how to extend the business would have to be considered, and the matter of a special fishery would come up. The success of such an enterprise must depend on the quantity of fish and on the ability of the lumpfish to maintain itself in the face of the increased drain. A better knowledge than we have at present of the movements and especially of the haunts of the fish during most of the year, would be also useful, for fishermen should know all these things in order to make the most of their time and investments.

As far as we can judge the shore waters are well stocked, especially in April, May and June, and in some places, during the whole summer and autumn. Otter trawls or similar gear operated along shore at such times should prove effective, and salmon and other nets, set, if possible, in advance of the season for their respective fisheries and with leaders somewhat parallel to the shore, should make large catches, at least during the spawning migration. It is unlikely that the use of such means will exhaust the stock, for the lumpfish are maintaining themselves well in the North sea and Cattegat; indeed the annual catch has been increasing for some years. Over-fishing seems to be depleting the stock frequenting the Swedish shores of the Baltic, but it is unlikely that we would be confronted with a decline for many years.

It would not only be interesting from a scientific standpoint but of much importance from an economic one to locate the autumn and winter haunts of this fish. Then the fishermen would know just where to go and what kind of means to employ for its capture. This has proved a difficult matter elsewhere.

In 1901 an expedition for this purpose was fitted out in the Baltic which spent nearly two months, September and October, searching for the autumn haunts of the large lumpfish which approach the shores in spring, but did not succeed in locating them. It did find a comparatively small quantity, but it was made up of individuals too small to be of much commercial value, and from both the business and scientific standpoint it was a failure, except for its negative results. We have the same problem to solve. From the middle of April to the middle of June, or a little later, large lumpfish are plentiful around the shore; after that they disappear. If the fishery were to expand to large proportions in Canada, the locating of such autumn and winter grounds will mark a new and important step in its development. It is true that operations could not be carried on in the gulf during the winter, but the Bay of Fundy and Atlantic littoral of Nova Scotia would be accessible all the year.

